MERCURY EMISSIONS FROM MOTOR VEHICLES

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Overview

- Why was this program initiated?
- What methods were used?
- Results and lessons learned.
- Emission Inventory implications.

Why did we conduct this program?

- No direct vehicle emission studies had measured mercury in exhaust.
  - Typically used XRF (particulate only).
- Recent studies suggest that motor vehicles may be contributing to environmental mercury levels.
  - Sediment mercury associated with proximity to high traffic volume locations.
  - Tunnel studies measured particulate mercury.
  - Mercury measured in crude oil and fuels.
- National inventory estimates based on ½ the detection limit of the XRF method.
  - Mobile sources becoming a more significant portion of the inventory with implementation of Hg MACTs.

Project Objectives

- Conduct a pilot study with Univ. of Michigan researchers to determine presence of mercury in vehicle exhaust.
- Apply more sensitive measurement methods to conduct motor vehicle testing.
- Identify potential mercury sources from motor vehicles (not including switches).

Vehicles Tested

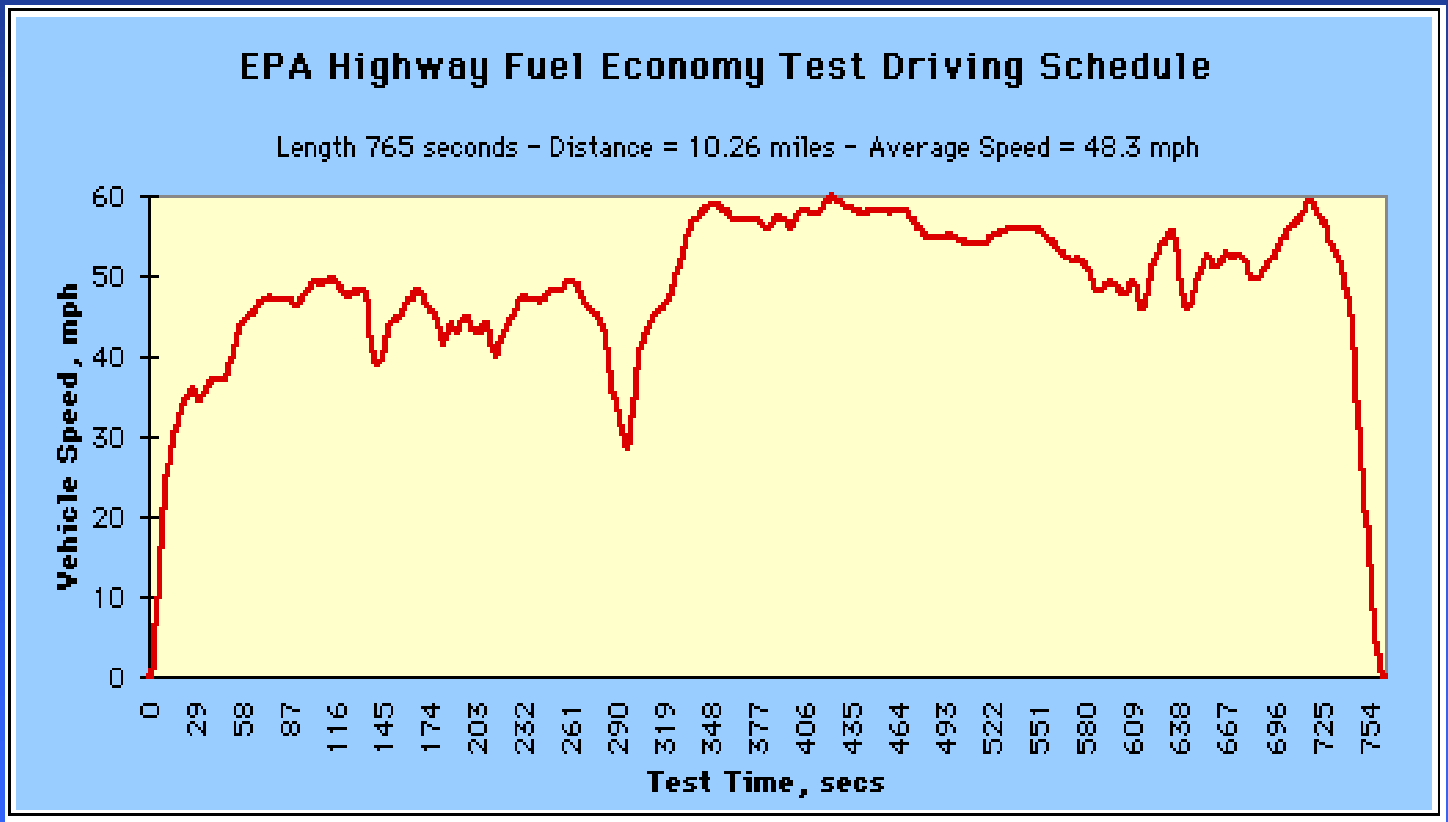
- Gasoline
  - 2001 Ford Crown Victoria (13,440 miles)
  - 1996 Jeep Cherokee (76,950 miles)
  - 1995 Chevy Astro Van (26,800 miles)
- Diesel
  - 2002 General Motors Short Haul Utility Truck (2,538 miles)

Testing Procedures

- EPA single roll chassis dynamometer.
- Vehicles conditioned prior to sampling.
- Tunnel and sample lines conditioned prior to and between sampling events.
- Two separate test cycles per vehicle.
- Three consecutive driving cycles composited for each sample.

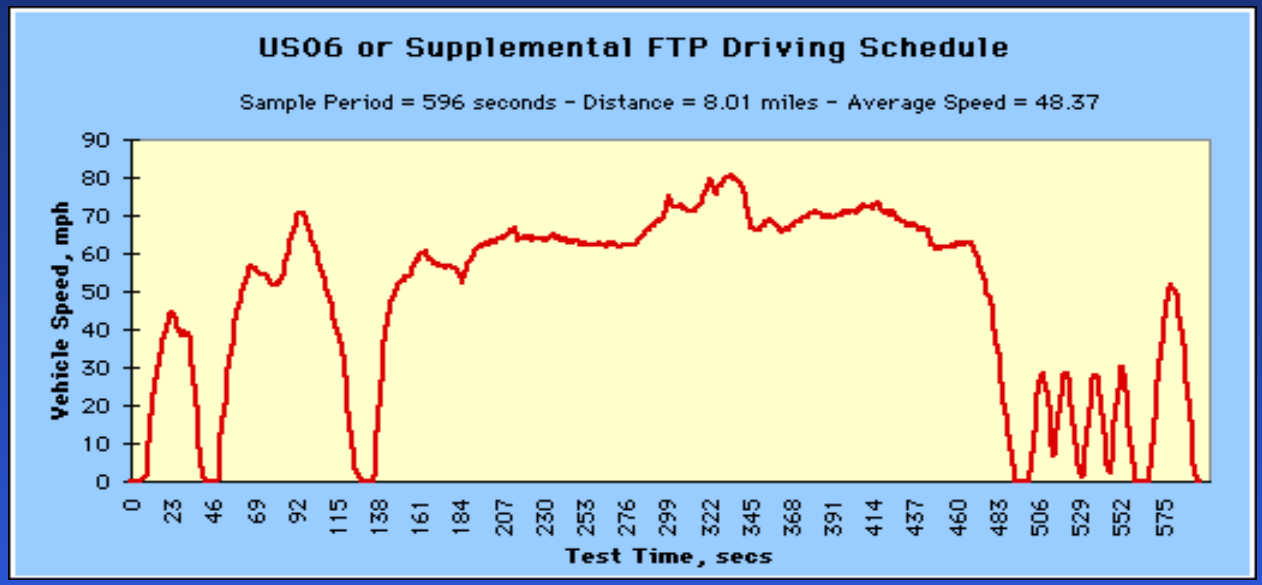
Driving Simulation

Gasoline and Diesel Vehicles

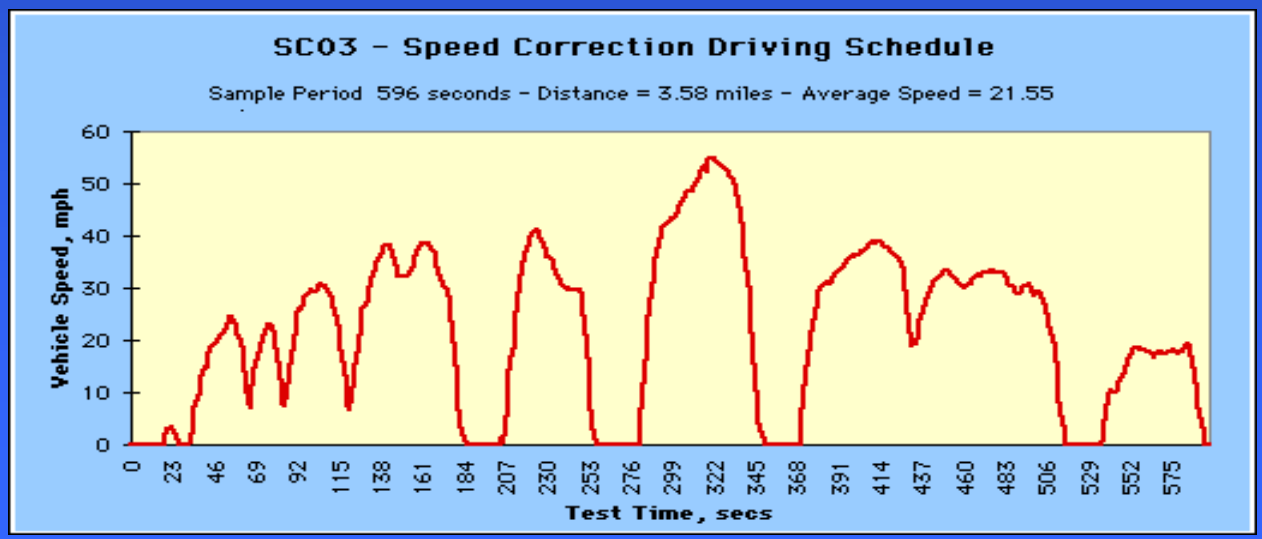


Driving Simulation

Gasoline

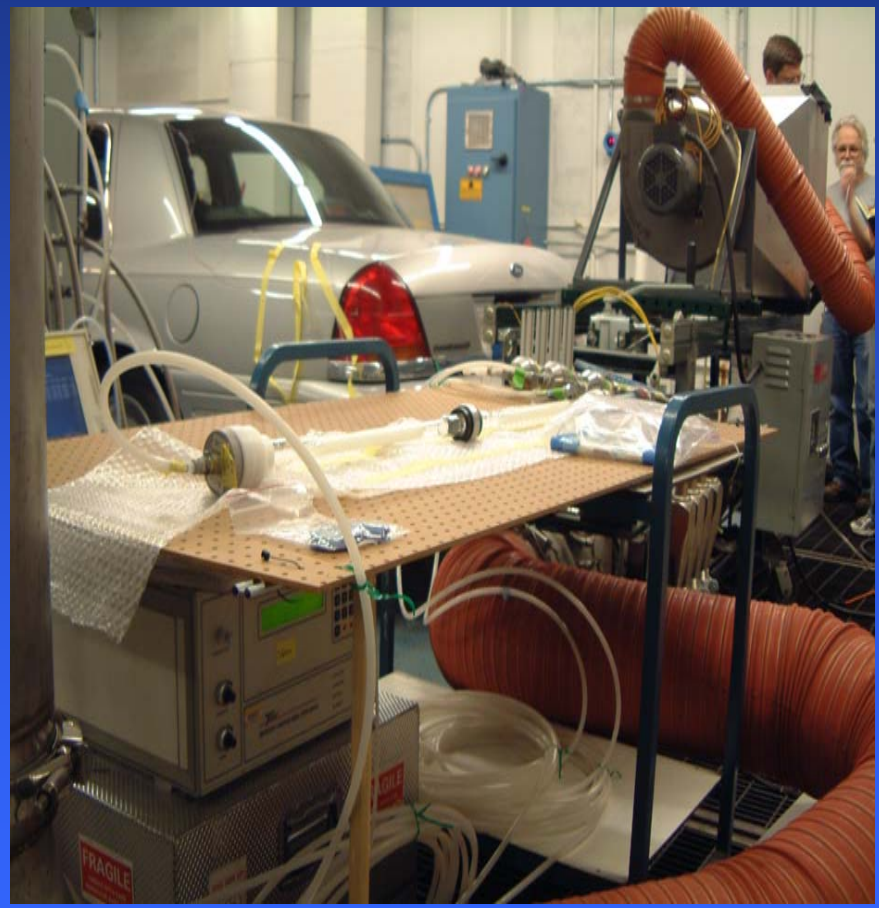


Diesel



Measurements

- Tailpipe Emissions
  - Continuous Hg
    - Tekran CVAFS
  - Integrated gas and particle phase
    - Denuders
    - Filter packs
  - Continuous HC, NOx, CO, CO2
- Vehicle Fluid Sampling
  - Fuel, Oil and Coolant
- Brake Analysis
  - Swab and Pad samples
- Blanks
  - Dilution air
  - Dynamic tunnel
  - Filter and denuder



Mercury Emission Rates

Test Vehicle/Driving Cycle	Number of Tests	Emission Rates (ng/mi)
Light-duty gasoline vehicles HWFET tests	3	0.3-0.5
Light-duty gasoline vehicles US06 tests	2*	1.2-1.4
Heavy-duty diesel vehicle HWFET test	1	11.1
Heavy-duty diesel vehicle SC03 test	1	6.4

* Smoking brakes occurred during one US06 gasoline vehicle test.

Fuel, Oil and Coolant Hg Content

Fluid Type	LDGV Fluid Concentrations (ng/L) (n)	HDDV Fluid Concentrations (ng/L)
Fuel	52-189	4.2
Lubricating Oil	239-578	15
Engine Coolant	0.2-2.5	6.9

Comparison of Fuel Concentrations

Fuel Type	EPA/UM Study	Liang (1996)
Gasoline (ng/L)	52-189	162-1,050
Diesel (ng/L)	4	339

*Liang et al., Science of the Total Environment 187:57.

Mercury from Brakes

- Dynamometer malfunction resulted in smoking brakes during one gasoline vehicle test.
- Dilution air Hg levels 50x greater.
- Brake swab and pad samples collected on all vehicles
- All swab samples had detectable levels of Hg.

Emission Inventory Relevance

- Results confirm presence of mercury in motor vehicle exhaust.
  - Emission factors less than values based on XRF detection limits.
  - Potential inventory contribution from mobile sources uncertain, likely between 0.1 and 10+ tpy.
    - Small number of vehicles sampled likely not representative of national fleet.
    - Multiple uncertainties and limitations in pilot test results.

What Questions Remain?

- Method of quantitatively collecting divalent mercury.
- Assessment of the variability in Hg content in fuels and oils.
- Influence of cold starts on total Hg emissions.
- Contribution of brake wear and other sources to total emissions.
- Contribution of non-road sources.
- Presence of high emitters, notably for gasoline vehicles.

Acknowledgements

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